

SOUTHWEST FISHERIES SCIENCE CENTER
FIRST AND SECOND QUARTER REPORT - FY 2004
For the Period October 1 - March 31

Submitted by: Roger Hewitt, Division Director, Fisheries Resources Division

Title of accomplishment of milestone: Complete manuscript describing the first age-based temperature dependent population model for market squid (*Loligo opalescens*).

Current status: The manuscript is complete. Priorities and potential funding for future squid research will be discussed with industry representatives on April 16th, at a meeting at the SWFSC.

Background information: Squid are both ecologically and economically important within the California Current. Ecologically, they are a principal food for some marine mammals and sharks and form a major link in the ecosystem. Economically, market squid has become a 41 million dollar fishery, and the catch rates in the southern California Bight have increased exponentially since the early 1980's (Fig. 1).

While the exponential increase is remarkable, almost unbelievable is the near collapse of the fishery during El Niño, and it's subsequent rebound only a year later. Given the short life (~6 mos.), low fecundity (~3000 eggs), semelparous nature, and its response to El Niño, there is a strong likelihood that squid will respond to the environment. Clearly, development of an indicator that can predict El Niño will help the fishery, but an understanding of how the environment impacts the population persistence is critical and more important to the long-term management of this species

Purpose of Activity: To investigate whether an environmental indicator can predict what will happen in the squid fishery, for incorporation into a management model.

Description of accomplishment and significant results: The disappearance of squid during El Niño is not the result of movement from the principle fishing grounds. Evidence from NMFS trawl surveys shows that squid disappear from the shelf and slope from Pt. Conception to Vancouver, B.C. and para-larval surveys conducted as part of CalCOFI show that during El Niño, there is little if any production in the Southern California Bight (Fig 2).

We have been able to develop indices of the probability of fishery collapse during El Niño using SST and CSL several months prior to the fishery (Fig. 3), yet this type of index will provide little advice in managing this species over the long-term. In order to develop an environmental index that may be useful for management, we have been exploring the relationship between growth rate variability and sea surface temperature.

There is a clear negative relationship between hatch month SST in the southern California Bight, and the mean growth rate of squid. Yet, there is no difference between the growth rates of squid in El Niño (1998) and La Niña (1999) years when growth is examined in relationship to hatch month temperature. This consistency is useful in that we can develop a population model that has, at its center, a temperature relationship that can be derived from local and regional temperature index sites.

To investigate the effects of temperature on the population dynamics we have begun to develop the first age-based temperature dependent population model of any squid (Reiss *et al.* submitted CalCOFI Reports).

Mortality rates are fixed, and based on simple assumptions regarding the mean maximum age at maturity. Preliminary results show that even under conditions of similar environmental forcing, but with just a small amount of stochasticity added, long periods of high seasonal abundance are followed by periods of very low abundance, all driven by variability in the cumulative mortality directly attributed to temperature dependent-growth variability (Fig 4). Also interesting is the fact that in some years the rate of increase

approaches the levels of increase that have been observed in the fishery immediately following the El Niño periods.

Significance of accomplishment: The project has resulted in the first age-based, temperature dependent population model for market squid (*Loligo opalescens*).

Problems: None.

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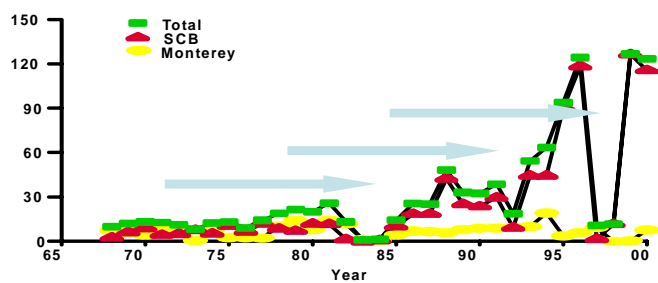


Figure 1. Market squid catch rates by year.

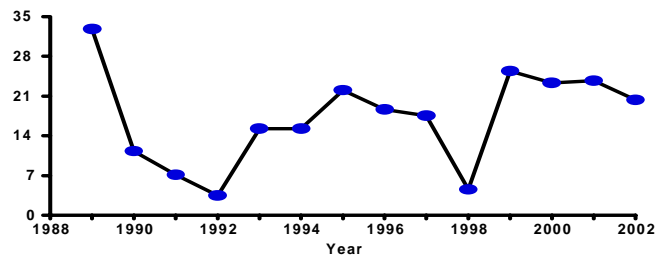


Figure 2. Percent positive tows by year in the SCB.

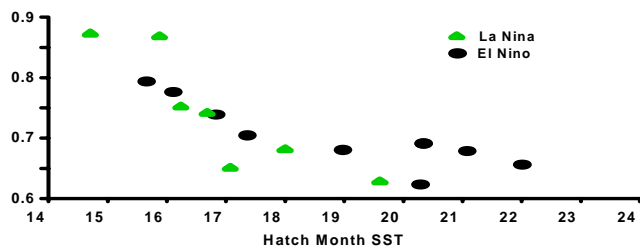


Figure 3. Growth rate by hatch month SST.

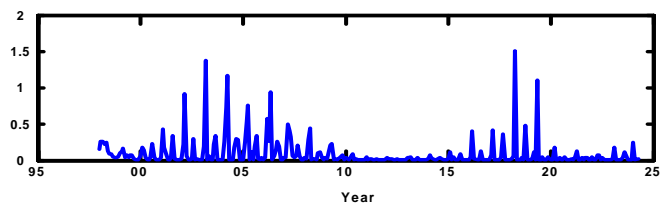


Figure 4. Number ('000s) by year.